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[54] **PROCESS FOR DETERMINING FLUCTUATIONS IN LEVEL IN MAGNETIZABLE LAYERS**
4 Claims, 1 Drawing Fig.

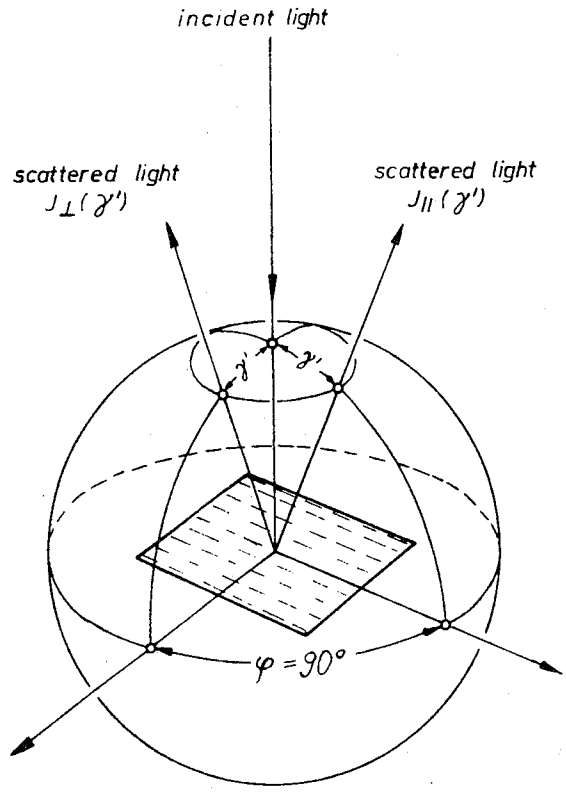
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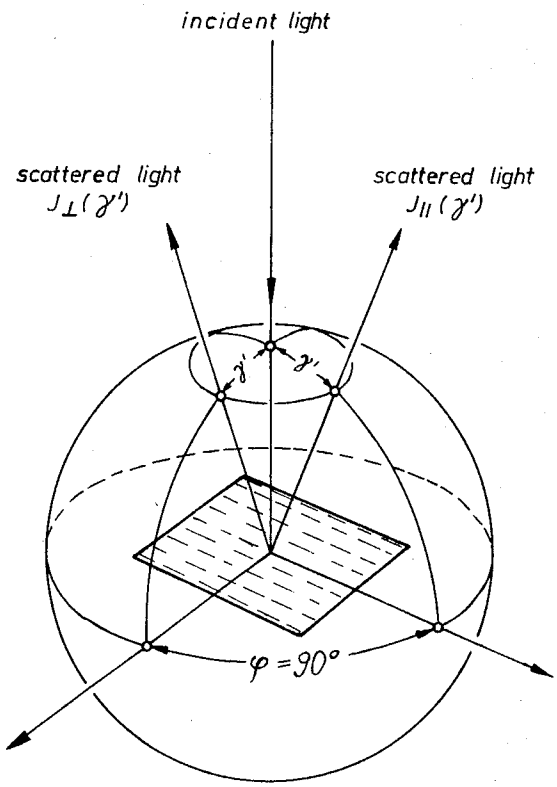
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ABSTRACT: The invention relates to a process for optical detecting fluctuations in level in magnetizable layers of recording materials, wherein a beam of electromagnetic waves is made to fall on the moving magnetizable layer and the intensity of the scattered radiation emitted is measured. The variations in the structure of the magnetizable layers reach the surface and thus alter the optical behavior of the magnetizable layer. The process is suitable for continuous checking of magnetizable tapes during the manufacturing process.





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PROCESS FOR DETERMINING FLUCTUATIONS IN LEVEL IN MAGNETIZABLE LAYERS

The invention relates to a process for determining fluctuations in level in magnetizable layers of recording materials.

Magnetic recording materials which are used nowadays for recording sound or images generally consist of a layer of binder which contains ferromagnetic particles and is applied to a supporting film of synthetic resin. The ferromagnetic material incorporated in the binder may, for example, be needle-shaped γ-ferric oxide particles. The length of these particles is about between 0.1 μ and 1 μ; their diameter of rotation is about 0.05 to 0.2 μ.

In the production of tapes, the ferromagnetic particles are generally subjected to a grinding process in the presence of the binder which is still liquid. After completion of the grinding process, the ground material is applied to sheets of supporting materials 1—2 m. in width by means of a casting machine. The magnetic properties of the tapes are improved by an orientation of the magnetic particles in the layer which is accomplished by exposing the layer after casting and before drying to a strong external magnetic field. To accelerate the drying process, a current of warm air is led over the moist layer. After drying is complete, the thickness of the magnetizable layers is of the order of 10 μ. The magnetic sheets which are 1—2 m. in width are then cut up into individual tapes about 1—2 cm. in width to give the magnetic tapes themselves. The tapes have to be tested to ensure that individual tapes will satisfy electroacoustic requirements. Complete testing of all tapes is very expensive on account of the time and apparatus involved. In many cases, therefore, only spot checks are carried out, i.e. a few portions of tape from one and the same sheet are tested. If these satisfy the electroacoustic requirements, it is assumed that all the tapes from the same sheet also satisfy these requirements, but again and again it is found that faulty tapes will thereby be passed over.

One important requirement which must be fulfilled by the magnetic tapes is that they must not cause any level fluctuations. The level is defined by playing back the sound level part of a standard tape. In the past, the level has been tested according to the following principle: A sinusoidal current having a frequency of 1 kilocycle per second is fed into the recording head. The recording head translates the current fluctuations into fluctuations of magnetic flux which are fixed on the magnetic tape. The fluctuations of magnetic flux fixed on the magnetic tape are then converted into voltage fluctuation by a pickup head. The effective value of these voltage fluctuations is taken to be a function of the tape location.

The measuring arrangements are such that a standard tape supplies a constant effective output voltage of 1.55 volt. The deviations of a test sample from this reference value are registered directly in decibel units on a recording instrument as function of the tape location.

A test sample is in order if the deviation from the reference value is constant and does not exceed $\pm$1.5 db.

The constancy of the tape must be such that any deviations which are regarded as fluctuations in level remain within the limits of $\pm$0.5 db.

The instruments required for this test are expensive, quite apart from the fact that the magnetic heads are quickly worn out and frequently have to be renewed. The test itself is time consuming as the tapes can only be run through at a given speed (38 cm./sec.).

Moreover, the test of the layer is only carried out on the finished tape. This does not make it possible to control the manufacturing process, and faulty coatings therefore cannot be eliminated.

It is the object of the invention to develop a simple process for detecting fluctuations in level which can be used equally well for high and low tape velocities, which in no way influences the tapes and with which the degree of fluctuation in the level can be detected during production of the tapes.

It has now been found that the fluctuations in level can best be determined by measuring the intensity of a scattered radiation which originates in an incident beam of electromagnetic waves, for example from the visible region of the spectrum. The process according to the invention is based on the finding that variations in the structure of the magnetizable layer reach the surface of the layer and have an effect on the surface of the layer, and that the optical behavior of the magnetizable layer is thus altered.

The invention will now be explained more fully with reference to the accompanying drawing. The sphere with the system of coordinates only serves to clarify the spatial relationships. An almost parallel beam of light from a stabilized light source meets the surface of a moving tape perpendicularly. For simplicity, electromagnetic waves from the visible region of the spectrum are the most suitable. The intensity of the scattered radiation is measured at a scatter angle of γ' by means of two photoelectric elements arranged in two planes which are perpendicular to each other. One of the photoelectric elements lies in a plane which passes through the incident light beam and the magnetic orientation of the tape (measured scatter intensity $=I_{\parallel}$). The other photoelectric element is in a plane which passes through the incident light beam and a straight line which is perpendicular to the magnetic orientation of the tape (measure scatter intensity $=I_{\perp}$). The following quantities can now be obtained:

$$I_{\parallel};\ I_{\perp};\ I_{\perp}-I_{\parallel}\equiv\Delta I;\ \frac{I_{\parallel}}{I_{\perp}}\equiv Q$$

Any of these quantities can be used for the measurements. The quantity Q is particularly suitable.

The optical method is, of course, not suitable for absolute measurement. The measuring apparatus must first be calibrated with a standard tape of the same type as the tapes which are to be tested. The standard tape is preferably a tape which consists of several portions of tape which have different but known fluctuations in level. One of the portions of tape should have practically no fluctuations in level, i.e. the fluctuations would be much less than the permissible value, e.g. less than $\pm$0.5 db; another portion should have large fluctuations in level, i.e. the fluctuations should be greater than the maximum permissible value e.g. greater than $\pm$0.5 db.

The adjustment is advantageously carried out as follows: The tape which is to be used for calibration is run through a machine and at the same time (*a*) the electroacoustic level fluctuations are measured in the usual manner and (*b*) the light scatter values are measured, for example the quantity Q. Both quantities are recorded on a double recording instrument and the sensitivity of the part of the recording instrument which registers the light scatter values is adjusted so that in the worst tape having very high fluctuations in level, the amplitudes of the light scatter values coincide with the amplitudes of the registered electroacoustic level fluctuations (measured in db.) (standard film). The zero level is obtained from the light scatter of the tape which has no fluctuations in level. When the adjustment has been carried out, the tapes which are to be tested can be measured by the method according to the invention solely and the tapes can then be classified. In this way, the tapes can be run at a much higher speed than was possible with the usual testing method.

The principle of an apparatus for checking magnetic tapes is described below:

The light from a stabilized light source is passed through a longitudinal bore, 3 mm. in diameter, to fall perpendicularly on the surface of the moving tape. The light beam incident on the surface of the tape is almost parallel. The scattered light is measured at a scatter angle of 60° by two lightpipes (diameter $\approx$3 mm.) arranged in two planes which are perpendicular to each other, and the outputs of the lightpipes are conducted to two photomultipliers. These measure the intensity of the scattered light ($I_{\parallel}$; $I_{\perp}$). After the usual amplification, the two measuring values may be registered separately or as difference or as a quotient. The two lightpipes are so arranged that one lightpipe receives the scattered light in a plane which passes

through the incident light beam and the direction of orientation of the magnetizable layer; the other lightpipe receives the light in a plane which passes through the incident light beam and a straight line which is perpendicular to the direction of orientation of the magnetized layer.

Such an apparatus may, of course, be modified in many ways and adapted to the requirements of an individual process.

The process according to the invention is eminently suitable for trouble-free continuous checking of magnetizable tapes at high and low tape velocities even during the manufacturing process.

The light scatter method can also be used for measuring the degree of orientation. In this case, the measuring cell is adjusted to the degree of orientation of the tape whereas for fluctuation in level it is adjusted to the electroacoustic level fluctuations. Whereas adjustment to the degree of orientation can be carried out on stationary tapes and on portions of tape of the size of the light spot, to adjust the light scatter arrangement for the measurement of fluctuations in level require the use of moving tapes, several metes in length. Furthermore, only the factors Q and ΔI can be used for measuring the degree of orientation whereas

$$I_{\parallel}(\equiv I_{\varphi=0°}) \text{ and } I_{\perp}(\equiv I_{\varphi=90°})$$

may also be used alone for measuring the fluctuations in level.

EXAMPLE

The following Table shows the correlation of light scatter grades of tapes with different fluctuations in level, with electrically measured grades.

Five grades of tape quality suitable for practical purposes are defined by a standard tape. The best grade has no fluctuations in level (Grade 1). Grade 2 corresponds to fluctuations in level much less than ±0.5 db. Grade 3 corresponds to fluctuations in level less than ±0.5 db. Grade 4 corresponds to fluctuations in level greater than ±0.5 db. Grade 5 corresponds to fluctuations in level very much greater than 0.5 db. The light scatter cell was adjusted by means of a standard tape by the method described above. Unknown tapes of the same type (i.e. of the same composition as regards the magnetizable particles and the binder) were graded by means of light scatter. Independently of this, grading was carried out by means of the usual electroacoustic method. The result of the comparison is shown in the Table. Intermediate values, e.g. 2—4, indicate that the test sample contains parts corresponding to Grade 2 and parts corresponding to Grade 4.

TABLE

Tape No.	Light scatter	Electrical value
221	1—2	1
223	1—2	1—2
224	1—2	1—2
225	2—3	2—4
226	2—3	3—4
227	3—4	3—4
229	3—4	3—4
230	2—3	2—3
231	1—2	1—2
232	2—3	2—4
233	1—3	2—3
234	3—4	3—4
235	2—4	2—4
236	3—4	3—4
237	1	1
238	1—2	1
239	5	5
240	1—2	1
241	1—2	1

The results fully satisfy the requirements in practice.

We claim:

1. A process for determining fluctuations in level in magnetic recording materials which contain at least one magnetizable layer consisting of a nonmagnetic binder to which particles are applied by casting, which cast particles are subsequently magnetizable in a magnetic orientation so that variations in light-scattering capabilities are present in the surface structure of the layer, the improvement of projecting a beam of electromagnetic waves incident on the surface of the layer, said beam consisting of substantially parallel waves, producing scattered radiation of said incident beam from said surface, said scattered radiation being of varying intensity, receiving radiation from said surface in at least two detecting receivers along radiating beams of divergent angles to the axis of the incident beam, said reception in a first of said receivers being along a plane passing through the incident light beam and magnetic orientation of said particles when magnetized, said reception in a second of said receivers being along a plane passing through the incident light beam and the perpendicular to said magnetic orientation and measuring the intensity of the emitted scattered radiation.

2. The process according to claim 1 in which the layer is moving under the incidence of the beam.

3. The process according to claim 1 in which a beam of light from a stabilized light source is incident on the layer surface.

4. The process according to claim 3 in which the radiated beams are received by photoelectric cell receivers.